The Solar Orientation of the Gothic Cathedrals of France

International Journal of Sciences

Research Article Volume 3 - April 2014 (4)

The Solar Orientation of the Gothic Cathedrals of France

Amelia Carolina Sparavigna[1]

[1]Department of Applied Science and Technology, Politecnico di Torino, C.so Duca degli Abruzzi 24, Torino, Italy

Abstract: The orientation of the Gothic cathedrals of France can be easily discussed and investigated using the satellite maps. Except a few of them, these buildings have the apse facing the rising sun, according to a practice adopted during the medieval period.

Keywords: Sunrise amplitude, Solar azimuth, Archaeoastronomy, Gothic cathedrals

1. Introduction

Using the satellite images, it is easy to observed and analyze the orientations of architectonic landscapes. With the Google Maps for instance, we have discussed in two recent papers [1,2] some Mughal gardens and their planning, which are displaying an alignment with the azimuths of sunrise and sunset on solstices. Probably, the enclosures of these gardens have been created to become a symbolic horizon suitable to follow the path of the sun over the course of the year. Such a symbolic planning can be found for some ancient Chinese towns too [3,4]. Even a peculiar orientation with the setting of the sun on its Zenith passage can be observed; it is displayed by the axis of the Lion Rock Complex in Sri Lanka [5].

For what concerns the ancient European architectures, we can investigate if specific orientations exist and try to find a possible symbolic meaning of them too. Here we discuss the case of the Gothic cathedrals of France. From an analysis of several of them by means of satellite maps, we can determine that they have a solar orientation, in particular that they have their axis along the direction of the rising sun. Therefore, they were planned to be "ad orientem", with a specific symbolic meaning. Before discussing the architecture, let us analyze this meaning.

2. Ad Orientem

The Latin expression "ad orientem" means eastwards. In the catholic liturgy, it describes an eastward orientation of celebrating Mass, according to the "cosmic sign of the rising sun which symbolizes the universality of God" [6,7]. It is interesting to note that the earliest churches in Rome had the main entrance facing East and an apse with the altar to the West; the priest celebrating Mass stood behind the altar, facing East and so towards the people. According to Helen Dietz [8], when Christians in the Rome of the fourth-century freely began building churches, they located the sanctuary towards the West end of the building, with the symbolic proposal of imitating the sanctuary of the Jerusalem Temple. It was during the 8-th or 9-th Century that the position changed, and the priest began to face the apse, not the people, when this worship position in celebrating Mass was adopted in the Roman Basilicas [9]. Present-day Roman Missal prefers the priest facing people, but it does not forbid the "ad orientem" position for the priest when saying Mass, only requires that in new or renovated churches the facing-the-people orientation be made possible.

U. Michael Lang writes in [10] that for several religions, the position of worshippers and of worship buildings has a direction according to a "sacred orientation". Believing in a second glorious coming of Jesus Christ, the Christians saw the sunrise as a symbol of resurrection and therefore oriented the sanctuaries toward East. Here, we analyze the orientation of the Gothic cathedrals in France to see if the "sacred orientation" exist; we will see that an eastward orientation of the apse is a rule. Let us remember that eastward does not means "due East", therefore it is better to tell that the orientation of cathedrals is toward the direction of the sunrise.

3. The plan of Gothic cathedrals

Before the specific discussion of orientation, let us shortly remember some facts about the plan of Gothic cathedrals. A Gothic cathedral has usually a cruciform plan, given by apse, transept and nave (see Fig.1). The apse was first a semicircular volume covered with a hemispherical vault. In the Gothic cathedral, this term applies to a semi-circular or polygonal termination of the building at the liturgical East end, where the main altar is placed, regardless of the shape of the roof. From the beginning of the XIII Century in France, the apses were built as radiating chapels, as we can see in the Figure 2, where the cathedral of Amiens is shown.

Amelia Carolina Sparavigna (Correspondence)
d002040@polito.it, amelia.sparavigna@polito.it
+39-011-564-7360

The transept is a transverse section placed across the main body of a building. In Christian churches having a cruciform plan, the transept is the part separating the nave from the presbytery and the apse. Assuming the altar located at the East end of a church, a transept extends to the North and South. When the transept exceeds the sides of the building, the plan forms the shape of a cross, which is a "Latin cross". It is a "Greek cross" in the case that all four extensions have the same length. The "Latin cross" is the preferred plan of Gothic cathedrals in France.

The Gothic art and architecture in France began about 1140, due to the works of architects and abbots. One of them was the Abbot Suger (1081-1151). Autobiographical accounts are coming from the two books he wrote [11,12]. Suger remodeled the Abbey Church of Saint-Denis, in the northern suburbs of Paris, to achieve some new perspectives. Inspired by the theology of Dionysius, the Syrian Pseudo-Areopagite (ca. 500), Suger saw the universe consisting of the "Father of Lights" (God), the "first radiance" (Christ) and the "smaller lights" (the people) [13]. The church therefore needs to be closer to this universe of light, and this is reflected in Suger's use of heightened architecture and large windows. Moreover, Suger's architecture was full of symbolic meanings. Reference [13] is telling for instance, that the West façade of Saint-Denis cathedral served as "a stepping-stone on the way to Heaven towards the light of God". The same was for the architectural elements: the twelve columns in the choir symbolize the twelve apostles, while the columns in the ambulatory the twelve prophets.

4. The orientation of cathedrals

According to this highlight of light, a "sacred orientation" of a Gothic cathedral towards the rising of the sun is expected. To investigate this fact we can use the satellite maps (Google or Bing Maps) to measure the angle these buildings are forming with the West-East cardinal direction. We can use this direction as a reference axis for angles. Angles are positive or negative when they are counterclockwise or clockwise with respect to this axis. The measurement of the angle from satellite images is quite easy: it is immediately given by the direction of the roof (see for instance the case of the cathedral of Amiens, in Fig.3). Of course a check of this angle on the local horizontal plane could give more precise results. From the satellite, we assume an uncertainty of the angle of a half degree. After such measurements, a table of the cathedrals and corresponding angles can be given (see the Table I). This approach to satellite images to study of the architectonic planning has been proposed by the author in some papers on the orientation of ancient Egyptian temples and Roman towns [14-16].

At a first glance of Table I, some angles seems quite large, but when we compare them with the sunrise largest amplitudes for the latitudes of France (the red lines are corresponding to the North and South of France, in the diagram of Fig.4), we discover that only three buildings (Metz, Chartres and Le Mans) are not sunrise oriented. In the diagram of Fig.4, a positive angle corresponds to the sunrise amplitude on a day of spring or summer, then from the spring to the autumn equinox, whereas a negative angle to a day of autumn or winter. A null angle corresponds to an equinox.

4. Discussion and conclusion

The practice of the foundation of a church and its rite had been simplified in 1961, as told in Ref.17. In this document, the orientation of the building is not mentioned. A pre-Vatican II rite dated to the fifteenth century, required, before the construction of a new church, that the foundations of the building were marked out and a wooden cross placed where the altar had to be. Then the bishop blessed the foundation stone [18,19]. This rite too is not mentioning an orientation with the sunrise. But, as we can read in Ref.20, the Apostolic Constitutions [21], dated from the fourth century, prescribed that the shape of the church should be oblong, so that it would resemble a ship, that is "Aedes sit oblonga, ad orientem versa, et quae sit navi similis". Moreover, as reported in [20], the foundation begun on the day, or on the vigil, of the feast of the Saint in whose name the new building was to be dedicated. On the night preceding the foundation rite, Reference 20 is telling, the "bishop and people would watch upon the site of the future church, and, as soon as the first rays of the sun appeared upon the horizon, the direction or orientation of the church was so determined that the building faced towards that point of the compass. If this theory be true, it would enable us to find out the original dedication (or titular) of a church, where the lapse of time has caused it to be changed or forgotten". This rite, as described by the Benedictine monks, seems the ritual that the ancient Romans used for the foundations of their "castra" and towns [14].

Probably, a large part of the Gothic cathedrals listed in the Table I and here discussed was built on the sites of previous churches, maintaining their original orientations. In fact we see from Table I that there are several cathedrals dedicated to Saint Étienne having quite different angles with respect the cardinal East-West direction. According to [20], this means that the original dedication of the site was different. For what concerns the cathedral of Saint Denis, its orientation from the satellite maps is 19 degrees negative: considering the latitude, this angle corresponds to the sunrise azimuth angle (see [14-16] for definition) of about 20 October or 20 February. The feast of Saint Denis, celebrated since at least the year 800, was

added to the Roman Calendar in the year 1568, and celebrated on October 9 [22]. Therefore, there is a difference of ten days, perhaps due to the reform to the Gregorian calendar.

Let us conclude with a short remark on the Chartres cathedral: this is one of the three cathedrals among those of the list having an orientation outside the possible sunrise amplitudes. Chartres is located on a hill and the cathedral is on the top of this hill. For this reason, the visible horizon is larger and then a correction of the azimuth seems necessary, such as the effect of atmospheric refraction. In the case that corrections are not enough to have a sunrise orientation, let us add this "mystery" to the list of mysteries of this amazing cathedral [23].

References

[1] A.C. Sparavigna, The Gardens of Taj Mahal and the Sun, The International Journal of Sciences, 2013, Volume 2, Issue 11, Pages 104-107.
[2] A.C. Sparavigna, Solar Azimuths in the Planning of a Nur Jahan's Charbagh, The International Journal of Sciences, 2013, Volume 2, Issue 12, Pages 8-10.
[3] A.C. Sparavigna, Sunrise and Sunset Azimuths in the Planning of Ancient Chinese Towns, The International Journal of Sciences, 2013, Volume 2, Issue 11, Pages 52-59.
[4] A.C. Sparavigna, A Solar Orientation in the Town-Planning of Xanadu, Archaeogate, 7 June 2013.
[5] A.C. Sparavigna, The Solar Orientation of the Lion Rock Complex in Sri Lanka, The International Journal of Sciences, 2013, Volume 2, Issue 11, Pages 60-62.
[6] Joseph Ratzinger (Pope Benedict XVI), The Spirit of the Liturgy, Ad Solem, 2006, page 64.
[7] The expression "ad orientem" is often used to mean the priest facing the apse or wall behind the altar, that is, with priest and people looking in the same direction, even if the apse is not oriented westwards, as in the ancient churches of Rome, or eastwards, as in the Gothic cathedrals. The "ad orientem" worship is opposed to that called "versus populum", in which the priest faces the people.
[8] Helen Dietz, The Eschatological Dimension of Church Architecture: The Biblical Roots of Church Orientation, The Sacred Architecture, 2005, Volume 10, Pages 12-14.
[9] The Oxford Dictionary of the Christian Church, Oxford University Press 2005, articles "orientation", "westward position", "eastward position".
[10] Uwe Michael Lang, Turning Towards the Lord: Orientation in Liturgical Prayer, Ignatius Press, 2004.
[11] Erwin Panofsky, editor and translator of Suger's Latin memoirs, is telling that Suger, as a young boy born to lowly parents, was dedicated as an oblate or lay novice to Saint-Denis at the age of nine or ten. Appointed abbot in 1122, Suger's main goal was to honor God and St.Denis through the beautification of his church.
[12] Erwin Panofsky, Abbot Suger on the Abbey Church of Saint-Denis and Its Treasures, Princeton University Press, 1946.
[13] The Abbey Church of Saint-Denis: Birthplace of Gothic Art and Architecture, Athena Review, Vol.4 No.2, http://www.athenapub.com/14suger.htm
[14] A.C. Sparavigna, The Orientation of Julia Augusta Taurinorum (Torino), http://arxiv.org/abs/1206.6062
[15] A.C. Sparavigna, The Sunrise Amplitude Equation Applied to an Egyptian Temple, http://arxiv.org/abs/1207.6942
[16] A.C. Sparavigna, The Orientation of Trayans' Town of Timgad, http://arxiv.org/abs/1208.0454
[17] Rite of Dedication of a Church and an Altar 1978, International Committee on English in the Liturgy, Inc. (ICEL), www.liturgyoffice.org.uk/Resources/Rites/RDCA.pdf
[18] http://oce.catholic.com/index.php?title=Corner_or_Foundation_Stone
[19] Va. Aa., Wikipedia, en.wikipedia.org/wiki/Foundation-stone, see also www.liturgialatina.org/pontificale/040.htm
[20] Benedictine Monks of Buckfast Abbey, The Laying of the Foundation-Stone of a Church, Ignatius Press, January 1927, available at www.catholicculture.org/culture/library/view.cfm?recnum=3661
[21] Va. Aa., Wikipedia, en.wikipedia.org/wiki/Apostolic_Constitutions
[22] Va. Aa., Wikipedia, en.wikipedia.org/wiki/Denis
[23] Louis Charpentier, The mysteries of Chartres Cathedral, Veronica's Books, 1966.

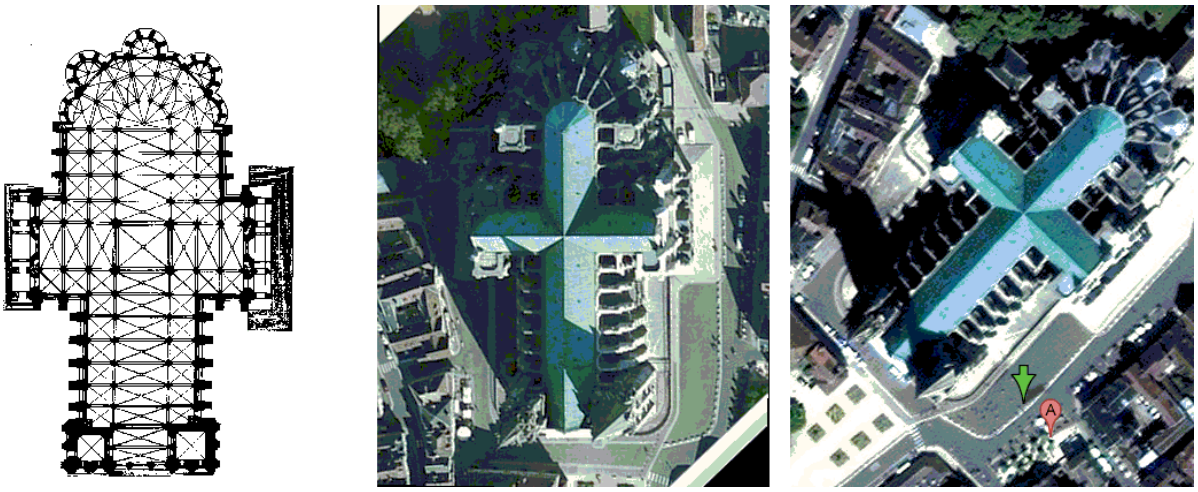

Figure 1 - On the left we can see the floor plan of the Chartres cathedral. In the middle and on the right, the cathedral in satellite images. Note the cruciform structure. In the middle the image is rotated; on the right we see the orientation of the cathedral as it is (Google Maps).

Figure 2 - Radiating chapels of the Amiens cathedral (from the Google Maps).

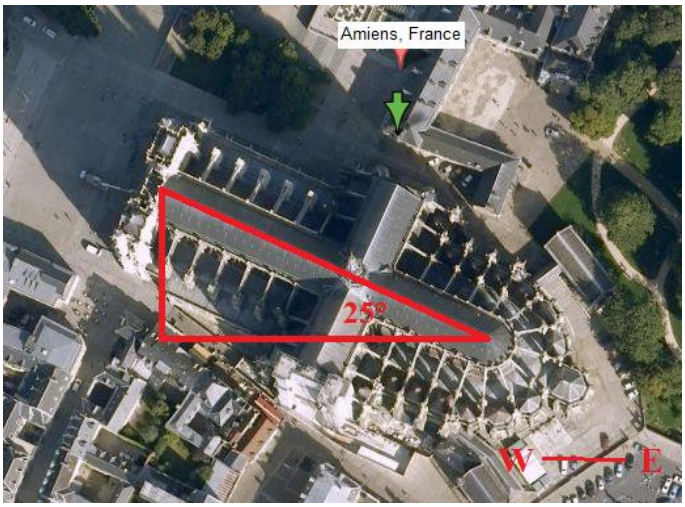

Figure 3 - The West-East direction is giving the reference axis. Angles are positive or negative when they are counterclockwise or clockwise. In the case of the Amiens cathedral the angle is of 25 degrees negative.

Table I

Metz, Saint-Étienne, 1220, 49° positive
Chartres, Notre-Dame, 1194, 46.5° positive
Troyes, Saint-Pierre-et-Saint-Paul de Troyes, 1228, 35.5° positive
Limoges, Saint-Étienne, 1273, 35° positive
Rheims, Notre-Dame, 1211, 31° positive
Strasbourg, Notre-Dame, 1225, 29.5° positive
Nevers, Saint-Cyr-et-Sainte-Julitte, 1212, 26.5° positive
Chalons-en-Champagne, Saint-Étienne, 1230, 17° positive
Tours, Saint-Gatien, 1236, 17° positive
Evreux, Notre-Dame, 1250, 16° positive
Auxerre, Saint-Étienne, 1215, 11.5° positive
Bordeaux, Saint-André, 1250, 9.5° positive
Toulouse, Saint-Étienne, 1273, 9° positive
Sens, Saint-Étienne. 1143, 4.5° positive
Langres, Saint-Mammès, 1150, 4° positive
Soissons, Saint-Gervais-et-Saint-Protais), 1176, 2.5° positive
Meaux, Saint-Étienne, 1200, 0° null
Carcassonne, Saint-Nazaire, 1267, 2.5° negative
Clermont-Ferrand, Notre-Dame-de-l'Assomption, 1248, 3.5° negative
Laon, Notre-Dame, 1150-1156, 3.5° negative
Beauvais, Saint-Pierre, 1225, 14.5° negative
Bourges, Saint-Étienne, 1195, 19° negative
Saint-Denis, Abbey of Saint Denis, 1135-1136, 19° negative
Rodez, Notre-Dame, 1277, 19° negative
Narbonne, Saint-Just, 1286, 21° negative
Bayonne, Sainte-Marie, 1258, 21.5° negative
Senlis, Notre-Dame, 1151-1153, 22° negative
Paris, Notre-Dame, 1163, 25° negative
Amiens, Notre-Dame, 1220, 25° negative
Rouen, Notre-Dame-de-l'Assomption,1200, 26° negative
Bayeux, Notre-Dame, 1180, 27° negative
Noyon, Notre-Dame, 1150, 28° negative
Le Mans, Saint-Julien, 1217, 54° negative

Table 1 - List of Gothic cathedrals after it.wikipedia.org/wiki/Cattedrali_gotiche_francesi

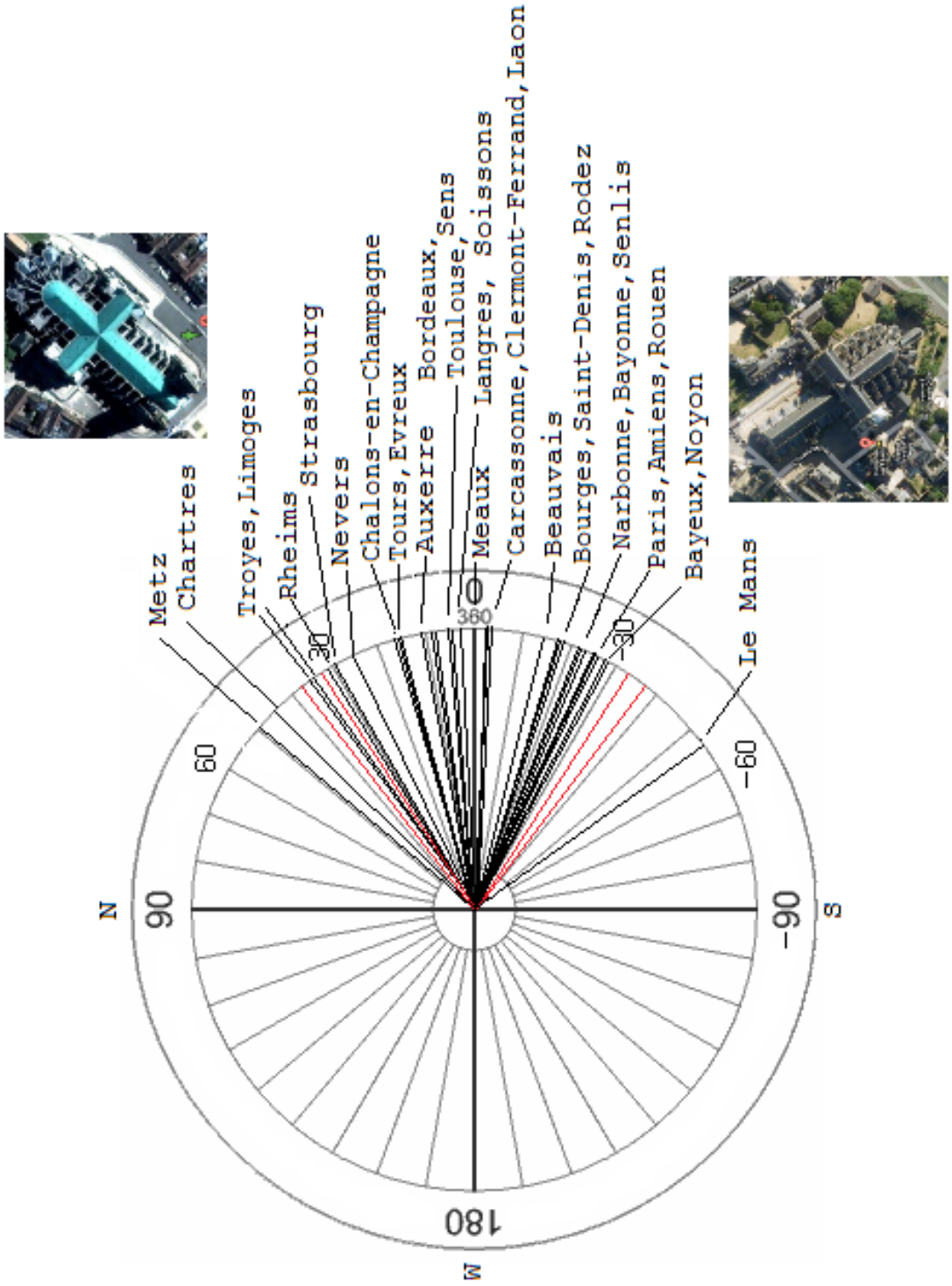

Figure 4 - The angles of the Gothic cathedrals in France on a polar diagram. The red lines correspond to the largest sunrise amplitude for the North and South of France. We see that only three building are not oriented with the sunrise. They are at Metz, Chartres, and Le Mans.